Development of Gas Scintillation Proportional Counter (STATES AND STRUCTURES-Atomic and Molecular Physics)

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Properties of gas scintillation proportional counter are investigated for Mn K X-ray spectra. The energy resolution (8.9%) on this type of the counter has twice as good as that (19%) of Xe gas sealed proportional counter. In the counter, a distortion of the pulse-height distribution due to a low-energy tail is observed. This fact can be attributed to the penetration of high energy X-rays in the accelerating region. Therefore, it is considerable that the tail may be enhanced for higher energy photons.

Keywords:Gas Scintillation / Proportional counter / Mn K X-ray / Pulse-height distribution

Proportional counters have been most commonly used in various field of research due to the structural simplicity and the high quantum efficiency. The energy resolution of the proportional counter is about 40 % and insufficient for resolving characteristic emission lines for Al Kα. On the other hand, X-ray spectrometers are limited in use for wavelength dispersion. Therefore, gas scintillation proportional counters (hereafter abbreviated as GSPC) have a good potential for X-ray characteristics in the material sciences and X-ray astronomy. The physical processes which underlie the functioning of the GSPC are described elsewhere[1].

We have developed GSPC for the observations of the fluorescence X-rays below 1 keV. This energy region including L emission lines in 3d elements is recently being watched with keen interest. In this paper, we present the properties of Xe gas sealed proportional counter (as PC) and GSPC for Mn K X-rays. A distortion of the pulse-height distribution in low energy side appeared in GSPC. This phenomenon is discussed.

The GSPC used in this work is a parallel-mesh type one as shown schematically on **Figure 1**. The entrance window consists of 50μm thick Be of 30mm ϕ area. The outer surface of Be is coated with a dotite for electrical conductivity. The counter is filled with Xe gas which is purification for rare gases.

An X-ray photon absorbed in the first region produces a cluster of primary electrons. These electrons drift to-

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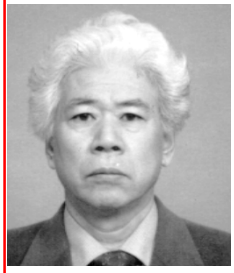
Scope of Research

In order to obtain fundamental information on the property and structure of materials, the electronic states of atoms and molecules are investigated in detail using X-ray, SR, ion beam from accelerator and nuclear radiation from radioisotopes. Theoretical analysis of the electronic states and development of new radiation detectors are also performed.



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wards the first mesh held at a potential V_1. This region is called the drift region. In the second region, the electrons are accelerated towards the second mesh at a potential V_2, and generate a number of photons, whose total number is proportional to the energy of the incoming X-ray photon. This is called the accelerating region. The performance of the counter is determined by the high voltage values V_1 and V_2, the gas pressure p[2]. We operate the counter with V_1=340 V, V_2=5660 V and p=1.5 atm. These values were constant during the course of the present study. As an X-ray source, Mn K X-rays (Radio-Isotope ^{55}Fe) was used. A sealed PC was prepared in this work for a comparison. A mixture of 97% Xe and 3% CO_2 at 250 torr was used for PC.

Mn K X-rays were used in order to evaluate the properties of the GSPC and PC.Pulse-height spectra for almost mono-energetic X-ray taken with the GSPC and PC are shown in **Figure 2**. The pulse-height spectrum is expressed in keV. Relative intensity and FWHM of Mn K photon energies are presented in **Table 1**. From this table, it is found that GSPC has twice as good an energy resolution as that of PC.

A characteristic feature in GSPC is that the pulse-height spectra reveal a taiil towards lower pulse-heghts as seen in **Figure 2** and **Table 1**. This phenomenon is not observed in PC. It is considerable that the tail may be attributed to the penetration of X-rays, and also influence the peak position of the spectrum in the fitting method.

The fact gives the suggestion that the high energy photons pass through the drift region and reach the accelerating region. Therefore, in near future, we attempt to explain the phenomenon in terms of the variation in the drift and acceleraing region.

References

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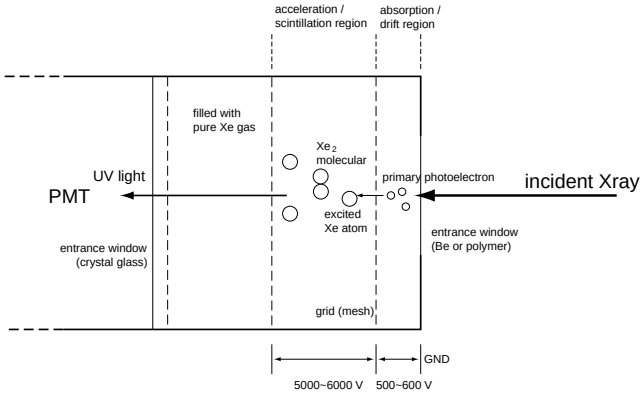

Figure 1. Schematic Diagram of GSPC

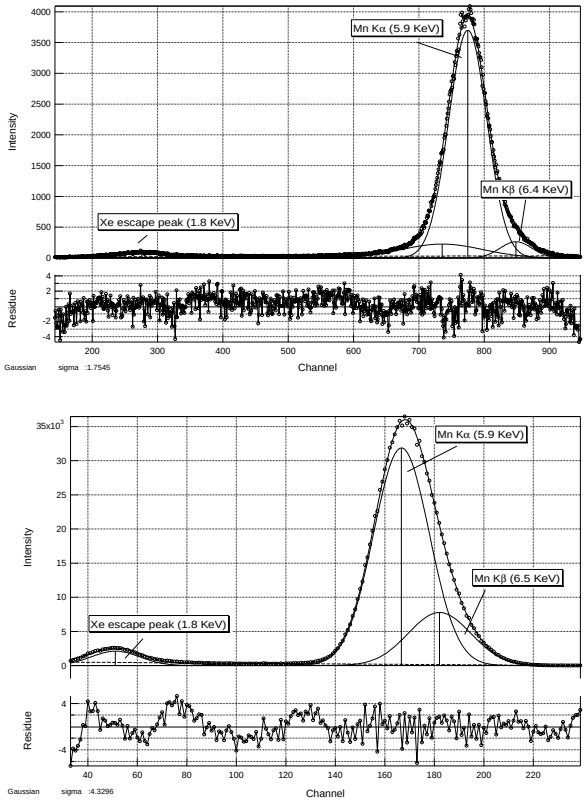

Figure 2. Pulse-height spectrum obtained by GSPC (up) and Sealed PC (down)

Detector	Peak (split by gaussian fitting)	FWHM (channel)	Relative Intensity(Integral)
GSPC	Mn Kα	8.9 %	100
	Mn Kβ	6.7 %	5.9
	Xe escape peak	33 %	2.5
	low energy tail	20 %	13
SPC	Mn Kα	16 %	100
	Mn Kβ	16 %	27
	Xe escape peak	45 %	5.7

Table 1. FWHM and relative intensity of eachpeak obtained by GSPC and Sealed PC